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AVIONICS MAINTENANCE TRAINING:
RELATIVE EFFECTIVENESS OF 6883 SIMULATOR AND ACTUAL EQUIPMENT

Test and Evaluation Plan

By

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TECHNICAL TRAINING DIVISION
Lowry Air Force Base, Colorado 80230

October 1979
Interim Report for Period July 1978 – March 1979

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Technical Training Division

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Currently there are insufficient empirical data to assist informed decision-making regarding the conditions of simulator effectiveness in test station maintenance training. The purpose of this interim report is to document the implementation of a detailed test and cost-evaluation plan currently employed in the 326X training field. The objectives of this plan are to obtain quantitative and qualitative data for comparatively evaluating simulator and actual test equipment on dimensions of (a) instructional effectiveness (b) time-savings (c) life cycle cost elements (d) attitudinal acceptance and (e) subsequent field performance. Cost-benefit scenarios involving variation in parameter values, e.g., student flow, aptitude levels, course length and specific life cycle cost element data will permit analysts to make more objective determinations concerning the effectiveness and efficiency of simulators compared to actual equipment given different situations.

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PREFACE

This document is the evaluation plan for assessing the cost/training effectiveness of the 6883 simulator, as compared to the actual 6883 test station equipment for training intermediate level F-111 avionics maintenance personnel at Lowry AFB. The project is being conducted for the Air Force Human Resources Laboratory, Air Force Systems Command, United States Air Force, Brooks Air Force Base, Texas. The evaluation plan outlined in this report was developed by the Social Systems Research and Evaluation Division of the Denver Research Institute, University of Denver, Denver, Colorado, under Contract Number F33615-78-C-0018. Dr. Louis F. Cicchinelli is the Principal Investigator and overall Project Director.

This work is being conducted under Project Number 2361-02-01. Dr. J. Deignan is the Task Scientist. Major D. Downing of the Human Resources Laboratory, Lowry Air Force Base is the Contract Monitor.

The author wishes to acknowledge the assistance of the individuals who contributed to this effort. Mr. K. Harmon and Mr. C. Treese of the Denver Research Institute have expended a great deal of effort in collecting background information necessary to design this plan. The cooperation of the Air Training Command staff at Lowry Air Force Base, in particular that of Msgt. D. Costa, Mr. J. Boston, Msgt. G. Bohnenberger, Sgt. J. Martin, and Sgt. L. Ratliff is greatly appreciated. Without their help the evaluation to be implemented would not be possible. The author wishes to thank the maintenance personnel contacted in the field, in particular Msgt. P. Griffin at Plattsburgh AFB and Msgts. V. Thrift and B. Walters at Cannon AFB, for their efforts in describing the job requirements of the field as they relate to training.

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SUMMARY

Objective

The objective of this study is to design and implement a comprehensive cost/training effectiveness evaluation of the 6883 simulator, as compared to the use of operational 6883 test station equipment for training intermediate level (I-level) F-111 avionics maintenance personnel. This report concludes Phase I of the project and provides the detailed evaluation plan to be implemented during Phase II.

Approach

The evaluation plan was developed in view of the constraints imposed by both the training and field environments. To ensure that the evaluation plan could be implemented without major disruption to existing training procedures, it was necessary to review the evolution of the F-111 maintenance training course since the specifications for the simulator were developed two years ago. To determine if the simulator, as delivered to Lowry Air Force Base in June 1978, could be used to meet current training objectives, it is necessary to assess the extent to which various simulator capabilities would be operational at the beginning of Phase II of the project. This information was collected by reviewing all relevant documentation, interviews with Air Training Command personnel, and direct observation of class proceedings.

Since the evaluation is also expected to assess the relative impact of the training mode (simulator vs. actual test station equipment) on subsequent performance in the field, it was necessary to conduct site visits to Cannon and Plattsburgh Air Force Bases. The primary purpose of the site visits was to determine the likelihood that job performance could be objectively measured, and attributed to the mode of training used in relation to the 6883 test station.

The final aspect of the evaluation will address the relative costs associated with using the simulator as compared to the actual test station for training. The cost model will be comprehensive so that it can be used to determine the relative costs of the two systems in a variety of decision making contexts.

Specifics

An evaluation plan was designed to address the following eight hypotheses:

- Practical training on the 6883 simulator and the 6883 test station results in identical performance on the standard ATC block tests for subsequent training;
- Airmen trained on the 6883 simulator and the 6883 test station are equally accurate in solving trouble-shooting problems;
- Airmen trained on the 6883 simulator and the 6883 test station are equally efficient in solving trouble-shooting problems;
- Airmen trained on the 6883 simulator and the 6883 test station operate the actual test station with equal proficiency;
- Airmen trained on the 6883 simulator and the 6883 test station are equally familiar and comfortable in operating the actual test station without supervision;
- Airmen trained on the 6883 simulator and the 6883 test station will acquire equivalent job-related experience;
- Airmen trained on the 6883 simulator and the 6883 test station will be equally capable of operating the 6883 test station in the field; and
- Airmen trained on the 6883 simulator and the 6883 test station are equally capable of operating assigned test stations, other than the 6883 station, in the field.

In this evaluation design, the mode of training is the experimental treatment. Specifically, the use of the 6883 simulator and the 6883 test station in the practical block of instruction in course 3ABR32634A are the two treatments. A comparison of classroom and field performance for the two treatment groups is expected to answer the general question: Do airmen trained on the 6883 simulator perform differently than airmen trained on the actual test station equipment? Due to a variety of environmental constraints, it will be necessary to consider 16 different groups in conducting some of the proposed analyses. These groups are defined by assigning students one of two levels of four variables of concern: training sequence, training mode, testing mode, and field assignment.

A total population of 180 F-111 avionics maintenance trainees is anticipated during the one-year evaluation period. Students will be assigned to the eight basic treatment groups defined by the levels of training sequence, training mode, and test mode. To ensure random assignment to the treatment groups, a random assignment plan will be implemented. The final factor to be considered which relates to the assignment of students to treatment groups is the procedure used to make field assignments. Evaluator control over this factor is not possible since assignments are made on the basis of demand in the field. Thus, any data collected subsequent to field assignments will be analyzed for airmen assigned to the 6883 or 6873 test station and airmen assigned to other automatic test stations separately.

Approximately eight additional hours of training will be required to collect performance data on each class of students. This test session will be added to the 6883 practical block of instruction resulting in a total of five days for that block of instruction.

Conclusions

The evaluation plan presented in this report can be implemented in the current training environment at Lowry AFB. The results of the evaluation will highlight the relative advantages and disadvantages of the 6883 simulator as compared to the use of actual test station equipment in training. It will also be possible to isolate any differences in maintenance personnel performance in the field which are due to the nature of training received, if any differences exist. Finally, the cost model developed will be exercised in a number of hypothetical decision making contexts to illustrate its flexibility and generalizability. The model itself will serve as a methodology for making comparative cost assessments in making future choices between the use of simulation and actual equipment in training.

INTRODUCTION

The following evaluation plan has been developed in view of information collected by the Denver Research Institute (DRI) evaluation team over the past six months. While the general framework remains consistent with the proposed contract statement of work, some minor modifications have been made in the manner of implementation based on an analysis of the training and field environments. The overall plan is divided into three components to facilitate reference to the three major evaluation components originally outlined in the proposal. Specifically, the three major components of the evaluation are:

- Classroom performance;
- Field performance; and
- Cost analysis.

This report is divided into five sections. The first section outlines the overall design to be employed, the next three sections correspond to the three major components of the evaluation plan, and a fifth section provides a chart summarizing the hypotheses to be tested and the data collection instruments and performance measures to be used. In each of the component-related sections, the primary objective and specific hypotheses to be tested are stated. Next, the findings of the preliminary investigations which most directly relate to that evaluation component are discussed. Finally, in view of those findings and the proposed evaluation effort, the methodology to be employed is outlined.

EVALUATION FRAMEWORK

From a theoretical point of view, the evaluation design required to assess classroom and field performance differences between simulator and actual equipment-trained students is extremely complex. The complexity stems primarily from two factors: the natural setting in which the evaluation will occur and the difficulty in defining the treatments. These issues will be discussed in detail throughout this section.

At a general level, the design to be employed approximates a "randomized controlled field trial" approach to evaluation. In a discussion of this methodology, Gilbert, et al. (1975) point out that the experimental units (students) "are randomly assigned to treatments or regimens and carefully followed to find out what the effect of the regimen might be." The "randomized controlled field trial" model includes three basic assumptions. First, the term "field trial" implies that treatments are being implemented in the field rather than simulated in the laboratory. Second, the term "controlled" implies that either the investigator or natural processes dictate the nature of treatments to be administered. Third, "randomized" refers to the use of chance to assign experimental units to specific treatment groups.

Treatment

Strictly speaking, in the present case, the mode of training is the experimental treatment. Specifically, the use of the 6883 simulator and the 6883 test station in the practical block of instruction in course 3ABR32634A are the two treatments. A comparison of classroom and field performance for the two treatment groups is expected to answer the question, "Do airmen trained on the 6883 simulator perform differently than airmen trained on the actual test station equipment?"

It should be obvious that the anticipated impacts of training are many. For example, students are expected to gain an understanding of electronics in general and to learn the operation and maintenance of the test station in both theory and practice. Further, some impacts will be immediate and can be measured at the completion of training; others will be more long range and can be measured only after field assignments are made. In short, to assess the impact of training, a variety of performance measures are required at a number of logical points in time.

The measurement of performance over time often presents a problem in designing evaluation studies. Campbell and Stanley (1963) point out that the measurement of performance itself can affect future performance. This is particularly true when assessing the impact of training since testing can be considered additional training. To further complicate the problem, the 6883 simulator provides training and testing capabilities not available on the actual test station equipment. Thus, it is necessary to use the simulator for performance testing, in particular for measuring trouble-shooting performance. At the same time, it is important to realize that students will be assigned to actual test stations in the field. Therefore, it is necessary to measure performance using actual equipment to ensure that performance levels are not due to the idiosyncracies of the simulated test station and its environment. In sum, to assess performance in the classroom, the two-by-two experimental design shown in Figure 1 is required. Treatment at this point in time is the mode of training in the 6883 practical block of instruction.

		Training: Simulator	Training: Actual Equipment
Testing	Simulator	A	B
	Actual Equipment	C	D

Figure 1. Basic Evaluation Design

Another aspect of the evaluation is to determine if any differences exist in performance in the field as a function of treatment. In measuring field performance at this point in time, it is important to note that four treatments must be considered. That is, the combinations of training and performance testing shown in Figure 1 constitute four distinct treatments. One additional factor further complicates the definition of treatment when assessing field performance: the nature of the field assignment. For our purposes, two types of assignments will be considered: (a) assignment to either the 6883 or 6873[1] test station or (b) assignment to other automatic F-111

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[1] The 6883 and 6873 test stations are identical except that the 6873 station includes an astrotracking test panel. This equipment is available only on the F-111 FB model aircraft. Training in the operation and maintenance of this station is identical since the operation of the astrotracking test equipment is learned on the job.

test stations. This dichotomy must be made because it is reasonable to assume that the impact of the mode of 6883 test station training would be more dramatic for personnel assigned to identical test stations than for personnel assigned to similar, but different, automatic test stations. In sum, any assessment of performance in the field must be made in view of the eight treatment groups shown in Figure 2.

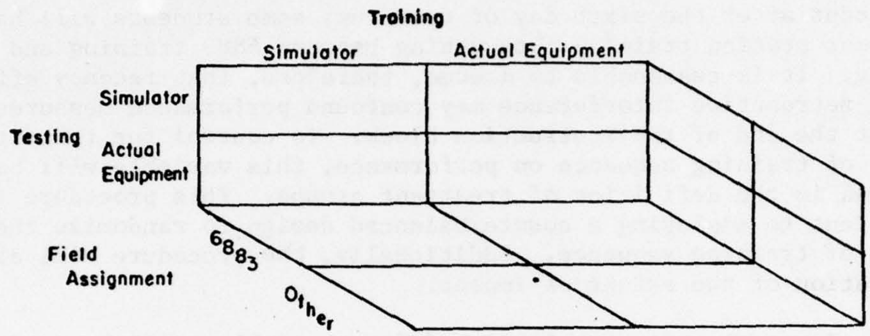

Figure 2. Treatment Groups for Assessment of Field Performance

The last factor which must be considered when assessing the impact of simulator training is the sequence of training immediately preceding testing. Recall that the practical 6883 training is only one portion of the total F-111 avionics maintenance course. In fact, the treatment (simulator vs. actual equipment) will only be administered for three consecutive days. Since this constitutes such a small portion of the training experience, it will be necessary to develop a design which will be sensitive to even slight differences in performance. Of particular concern then is the time between basic treatment (training) and testing. As the course is currently structured, all blocks of instruction will[2] be administered in a consistent sequence for both treatment groups. The major problem is within the 6883

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[2]Unscheduled deviations in the training sequence often occur, usually due to equipment malfunctions. Since there can be no control over this factor and the occurrence of malfunctions is random, the impact on performance is expected to be consistent across treatment groups.

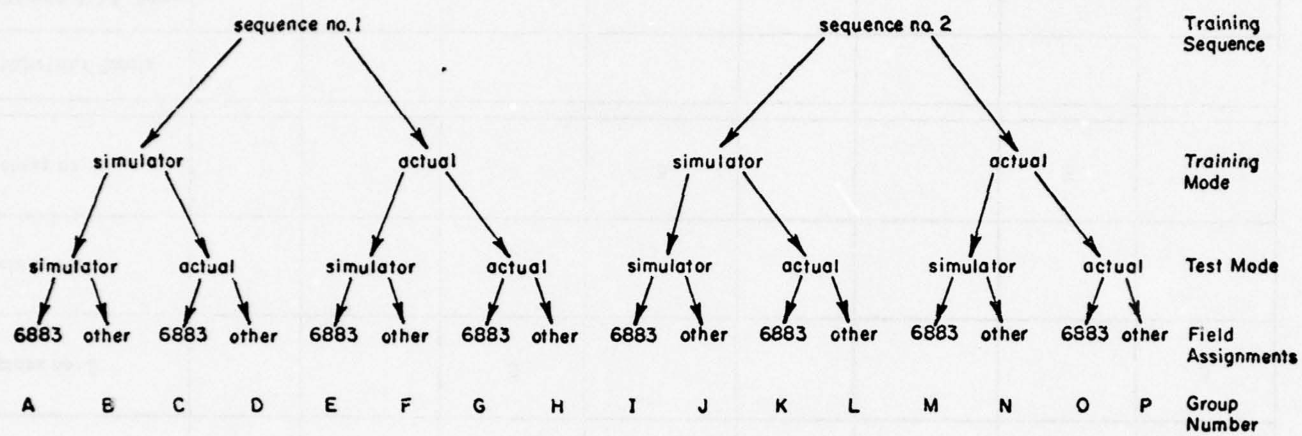
practical block itself. The duration of this instruction is six days: three days of training on the 6883 test station and three days on the 6886 test station. To maximize the amount of student contact with both test stations, each class will be divided into two groups. One group will receive training on the 6883 station for three days and then receive training on the 6886 station for three days. Simultaneously, the second group will receive the same training but in reverse order: three days on the 6886 station and then three days on the 6883 station. Since all testing associated with this evaluation will occur after the sixth day of training, some students will have 6886 test station training intervening between 6883 training and 6883 testing. It is reasonable to assume, therefore, that recency effects and/or retroactive interference may confound performance measures made at the end of the instruction block. To control for the potential impact of training sequence on performance, this variable will be included in the definition of treatment groups. This procedure is equivalent to employing a counterbalanced design to randomize the effect of training sequence. Additionally, the procedure will allow examination of the extent of impact.

In total then, two levels of four variables will be used to define 16 independent experimental groups (Figure 3).

Assignment to Treatment Groups

A total population of 180 F-111 avionics maintenance trainees is anticipated during the one-year evaluation period. Students will be assigned to the eight treatment groups defined by the levels of training sequence, training mode, and test mode as shown in Figure 3. To ensure an approximately equal number of subjects in each treatment group, the assignment plan shown in Table 1 will be implemented. From the table, it can be seen that "training class" is the unit of assignment to a level of training sequence and training mode; whereas "student" is the unit of assignment to a level of test mode. The plan shown in Table 1 is for a one-month period and assignment of units to treatments is essentially random. It is expected that the schedule will be continually adjusted in subsequent months to maintain approximately equal group sizes throughout the data collection period. Since the adjustment will be most likely necessitated by randomly occurring equipment malfunctions and changes in training schedules, the overall attempt to randomly assign students to treatment groups will not be compromised. Table 2 is the student assignment sheet which will be submitted to ATC personnel for each class.

Despite the effort to randomly assign students to groups, it is possible that observed performance will be a function of student aptitude. To justify attributing observed differences (if any) to training mode, it is necessary to consider preexisting individual differences among students. To address this issue, an analysis of the



Note: Not all groups are relevent in all analyses.

Figure 3. The 16 Groups Resulting From Consideration of the Four Variables Which Define the Treatment Regimen

TABLE 1

STUDENT ASSIGNMENT SCHEDULE FOR TESTING INDIVIDUALS

MONTH SAMPLE

PREVIOUS EXPERIENCE	Sequence no. 1 (6886 then 6883)				Sequence no. 2 (6883 then 6886)			
TRAINING MODE	actual	actual	simulator	actual	actual	actual	simulator	simulator
TESTING MODE	actual	simulator	actual	simulator	actual	simulator	actual	simulator
class no. 1	3					3		
class no. 2			3					3
class no. 3		3			3			
class no. 4				3			3	
MONTHLY Totals								
CUMMULATIVE Totals								

TABLE 2

STUDENT ASSIGNMENT TO TRAINING

Class Number: ______________ Number of Students: ______

FOR DRI USE ONLY

	Group Number
6886 practical then 6883 practical on actual equipment	
6883 practical instructor:	
1.	
2.	
3.	
4.	
6886 practical then 6883 practical on simulator	
6883 practical instructor:	
1.	
2.	
3.	
4.	
6883 practical on simulator then 6886	
6883 practical instructor:	
1.	
2.	
3.	
4.	
6883 practical on the actual test station then 6886	
6883 practical instructor:	
1.	
2.	
3.	
4.	

relationship between aptitude scores and scores on block exams and performance in the 6883 theory and practical blocks of instruction was recently completed on 104 airmen trained over the past two years.[3] The analysis indicates that only modest correlations exist between aptitude as measured by Air Force Testing protocols and performance in the 6883 training blocks. It is important to note that this analysis was based on previous block examinations which have been continually revised to reflect changes in course content. Therefore, these findings are not necessarily generalizable to the test instruments to be used in this evaluation effort. Thus, although no systematic bias due to aptitude is expected to confound the performance measures, these differences will be controlled by including an analysis of covariance in the proposed data analysis plan.

The final issue to be considered which relates to the assignment of students to treatment groups is the procedure used to make field assignments (cf. pp. 3-4). Evaluator control over this factor is not possible since assignments are made on the basis of demand in the field. Thus, any data collected subsequent to field assignments will be analyzed separately for airmen assigned to the 6883 or 6873 test station and airmen assigned to other automatic test stations. It is expected that the group sizes will be unequal on this factor because only a small number of trainees will be assigned to the 6883 or 6873 test stations.

Testing Schedule

Approximately eight additional hours of training will be required to collect proposed performance data on each class of students. This test session will be added to the 6883/6886 practical block of instruction, resulting in a total of seven days for this block of instruction. The sequence of events occurring on the test day are as follows:

- Trouble-shooting test on either the simulated or actual test station (practical);[4]

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[3]The details of this analysis were included as an appendix to the "Second Quarterly Status Report," to Human Resources Laboratory, Lowry AFB (1979).

[4]From Table 1 it can be seen that students in a single class are divided for the purpose of testing trouble-shooting ability. This procedure should result in an overall reduction in the time required for testing because testing on the simulator and actual test equipment can be conducted concurrently.

- Estimated Job Proficiency Test administered to all students; and

- Interviews with all students.

The nature of these data collection instruments is discussed in the remaining sections of the report. In addition to these performance measures, scores on the routinely administered performance checklists, prior and subsequent block exams, and aptitude tests will be analyzed.

It is important to note that while the testing schedule and plan of group assignments are specified at the outset, enough flexibility must be maintained so that student reassignment can be made on short notice to reduce the occurrence of lost or missing data. To assist in this regard, some general guidelines for dealing with the more typical problems will be developed. Additionally, a DRI staff member will be made continually available to assist in making these immediate decisions.

Data Analysis

Initially, the performance data collection instruments will be administered solely by Denver Research Institute (DRI) personnel, with the assistance of Human Resources Laboratory (HRL) and Air Training Command (ATC) staff. Interviews with students and instructors will be conducted by DRI staff. However, it is expected that this information will eventually be collected through the use of a self-administered questionnaire. Subjective ratings of field performance will be obtained for individual students from field supervisors using a self-administered questionnaire. Training in the use of this instrument will be provided by DRI.

All data will be aggregated and analyzed by DRI staff. Table 3 is the data collection/coding form to be used. This form provides an outline of all data to be collected on each student. The specific analysis and measures to be used are discussed throughout the remainder of this report, as they relate to specific hypotheses.

TABLE 3

STUDENT DATA COLLECTION FORM

	Item		Columns
Identifying Information	1. Group Id. Number	1.	1
	2. Student Name	2.	2-7
	3. Sex	3.	8
	4. Date of Birth	4.	9-14
	5. Social Security Number	5.	15-23
	6. Date of Arrival	6.	24-29
	7. Date of Entry	7.	30-35
	8. Class Number	8.	36-41
	9. Course Sequence Number	9.	42
	10. Instructor Code	10.	43
Aptitude Scores	11. General	11.	44-46
	12. Mechanical	12.	47-49
	13. Administrative	13.	50-52
	14. Electronics	14.	53-55
	15. AFQT	15.	56-58
Previous Block Scores	16. Fundamentals of Electronics	16.	59-61
	17. Intro. to Avionics AGE Principles	17.	62-64
	18. Cenpac	18.	65-67
	19. Datac	19.	68-70
	20. Data Logic Analysis of Counter Timer, Logic and Micrologic Power Supplies	20.	71-73
	21. CATE	21.	74-76
	22. Navigation and Weapons Delivery TS	22.	77-79
	23. Electronic Systems TS	23.	80-82
	24. Converter Flight Control TS	24.	83-85

TABLE 3 (cont.)

Group	Item		Columns
X	25. Electronic Systems TS (pract)	25.	86-88
X	26. Converter Flight Control TS (pract)	26.	89-91
Subsequent Block Scores	27. Computer TS	27.	92-94
	28. Attitude and Rate TS	28.	95-97
	29. Computer TS (pract)	29.	98-100
	30. Attitude and Rate TS (pract)	30.	101-103
	31. Displays TS	31.	104-106
	32. Video TS	32.	107-109
	33. Radar-Transmitter-Modulator TS	33.	110-112
	34. Video TS (pract)	34.	113-115
	35. RTM TS (pract)	35.	116-118
Special Information	36. Date of Graduation	36.	119-124
	37. Date of Elimination	37.	125-130
	38. Base Assignment	38.	131
	39. Report Date	39.	132-137
	40. Deviations in Training	40.	138-139
	41. Unique Errors Committed	41.	140-141
Experimental Data	42. Time 1; start test tape	42.	142-143
	43. Time 2; test failure	43.	144-145
	44. Time 3; id LRU malfunction	44.	146-147
	45. Time 4; verify and state cause	45.	148-149
	46. Time 5; id TS malfunction	46.	150-151
	47. Time 6; total test	47.	152-153
	48. Estimated Job Proficiency Test Score	48.	154-156

TABLE 3 (cont.)

Experimental Troubleshooting Test Data				Columns
	49.	Remove all jewelry	49. ☐	157
	50.	Test station preparation	50. ☐	158
	51.	Turn-on procedures	51. ☐	159
	52.	Feel/Trim visual inspection	52. ☐	160
	53.	Selection/hook-up of correct adapter	53. ☐	161
	54.	Cabling LRU to test station	54. ☐	162
	55.	Set MODE SWITCH to "normal"	55. ☐	163
	56.	Enter and request test number 830401	56. ☐	164
	57.	Verify test number, press START	57. ☐	165
	58.	Verify test date, press START	58. ☐	166
	59.	Does LRU pass test #300150	59. ☐	167
	60.	Testing halts at #300610; enter #300650, TEST REQUEST, START	60. ☐	168
	61.	Testing halts at #300755; when "go" press START, observe increasing + voltage, press START	61. ☐	169
	62.	Testing halts at #300764; when "go" press START, observe increasing - voltage, press START	62. ☐	170
	63.	Testing halts at #300824; enter #300830, TEST REQUEST, START	63. ☐	171
	64.	Testing halts at #301752; rotate OSCP. INPUT SIGNAL SEL switch to "digital multr"	64. ☐	172
	65.	Press NEG DC COUPLING switch	65. ☐	173
	66.	Press POS DC COUPLING switch	66. ☐	174
	67.	Set VERNIER to "fully cw"	67. ☐	175

TABLE 3 (cont.)

Experimental Troubleshooting Test Data (cont.)			Columns
68. Set V/DIV at .5.	68.	☐	176
69. Set SWEEP MODE on "auto."	69.	☐	177
70. Adjust to obtain display, observe sine wave	70.	☐	178
71. Determine that the Yaw Board TB3 is defective.	71.	☐	179
72. Rerun test tape from #301740.	72.	☐	180
73. Advise board replacement.	73.	☐	181
74. Rerun test tape from #301740.	74.	☐	182
75. Student should offer alternative explanations of malfunction.	75.	☐	183
76. After 5 minutes: Instructor suggests that "test station caused the malfunction."	76.	☐	184
77. After another 5 minutes: Instructor suggests that "the test program should be decoded."	77.	☐	185
78. Student decodes program in total.	78.	☐	186
79. Student decodes program in part.	79.	☐	187
80. Student identifies missing power input.	80.	☐	188
81. Student notes that power light is off.	81.	☐	189
82. Student suggests alternative explanations for lack of power.	82.	☐	190
83. Student suggests that a fuse has blown.	83.	☐	191

COMPONENT 1: SIMULATOR RELATED ISSUES

The primary objective of this component of the evaluation is to determine the relative advantages and disadvantages of the 6883 simulator as compared to the use of actual test station equipment in training. The specific null hypotheses to be addressed are:

Hy 1--Practical training on the 6883 simulator and the 6883 test station results in identical performance on the standard ATC block tests for subsequent training.

Hy 2--Airmen trained on the 6883 simulator and the 6883 test station are equally <u>accurate</u> in solving trouble-shooting problems.

Hy 3--Airmen trained on the 6883 simulator and the 6883 test station are equally <u>efficient</u> in solving trouble-shooting problems.

Hy 4--Airmen trained on the 6883 simulator and the 6883 test station operate the actual test station with equal proficiency.

Hy 5--Airmen trained on the 6883 simulator and the 6883 test station are equally familiar and comfortable in operating the actual test station without supervision.

In addition to testing these specific research hypotheses, the students and instructors will be surveyed to obtain their attitudes and perceptions of simulation as a training tool.

Relevant Issues

DRI originally proposed to rely heavily on existing test instruments to collect relevant data. Further, it was proposed to emphasize training on the 6883 simulator since previous test scores from students trained on the actual test station equipment would be made available to serve as baseline data. However, after completing a review of courses, it was found that the merger of 3ARB326XID (operations) and 3ARB326XOB is not the only major change in instruction over the past year. In fact, these two courses have undergone numerous modifications and the new combined course is continually being altered even at this late date. Associated with these course changes are changes in the test instruments used. Appendix A includes a table which shows the evolution of training objectives over the past three years for the 6883 theory and practical blocks of instruction. Most recently, the 6883 and 6886 test station practical blocks have been merged. These formal modifications, together with numerous "deviations," applied to nearly every class, make the use of test scores for previous classes as baseline data inappropriate. The table in Appendix B shows the 6883 block objectives formerly addressed and included in the X4A STS which are not currently included in the new 6883 instruction block. Additionally, over the past six months, students have been sporadically trained on either the 6883 simulator or the actual equipment, or both, depending on equipment availability and convenience. Thus, including data from this group in our analysis is also unjustified.

It should also be noted that for some instruction blocks, previous test scores do not exist. For example, while the XOB (maintenance) course has included an evaluation of student performance during the 6883 practical block by using a performance criterion checklist, no similar testing procedure has been employed in the X1D (operations) course. Student performance in this course has been rated as "satisfactory" or "unsatisfactory" on the basis of instructor's observations throughout the four days of training.

In the new course (3ARB32634A), students will spend three days on the 6883 test station during the practical block of instruction. This intensified, but shortened, period of instruction will certainly reduce the probability of observing major differences in performance due to training mode. Further, it will eliminate any "free" time during which to administer additional tests for evaluation purposes.

In sum, these aspects of the training environment pose a complex of potentially confounding variables which might obscure the measurements of any differences in performance due to the minimal intervention of three days for differential training. The following methodologies are planned to overcome many of these difficulties and to provide as much temporary control over the training environment as possible.

Methodology

The students in course 3ARB326X4A will be assigned to one of two groups. Some classes will receive the 6883 practical instruction exclusively on the simulator, while the remaining students will be trained exclusively on the actual test station equipment. The sequence of training in the 6883 practical block will be controlled such that approximately one-half of the students will receive each of the two possible sequences. Half of each class will then be tested on either the simulator or the actual equipment. This will result in a 2 x 2 design for each training sequence as shown in Figure 1.

Data Collection Instruments

The data collection effort associated with this component of the evaluation plan includes the use of existing performance tests as well as new data collection instruments.

As originally proposed, data will be collected using existing Air Force performance tests when appropriate. Therefore, the evaluation of some hypotheses will be based on the use of currently used end-of-block tests. Specifically, the performance on the end-of-block test for the 6883 practical block will be used to compare the performance of the treatment groups. Additionally, to examine the possibility that the mode of training affects subsequent classroom performance in non-6883 blocks, end-of-block scores for all training following the 6883 practical block will be compared for the groups.

A Trouble-shooting Test will be designed such that it can be administered on the simulator and the actual test station equipment in exactly the same manner. The test has been designed to allow examination of a student's ability to trouble-shoot Line Replaceable Units (LRUs) and the test station as an integrated system. The performance measures to be used are accuracy, time to completion, and nature of errors. The test protocol will include familiar and novel aspects. The data recording sheet associated with this test is shown as Table 4. If sufficient data is collected before the one-year collection period is over, one portion of the test administered on the 6883 simulator will be modified to include a problem which cannot be presented on the actual test station. Specifically, the simulated Yaw Computer trouble-shooting exercise will be included to examine the ability of students to generalize their training to an LRU with which no experience exists.

Finally, a structured interview format will be developed to obtain student attitudes and perceptions concerning the use of the 6883 simulator versus the actual test station in training. All students trained and tested on alternative equipment modes of presentation will be interviewed. To gain insight in the use of simulation in training from the instructor's point of view, all ATC personnel who have used both modes of training will be interviewed.

Hypothesis Testing

To assess hypothesis #1, the scores of the two treatment groups on the 6883 practical block test will be compared, assuming a separate test is administered by ATC. Additionally, the end-of-block scores for subsequent blocks (non-6883 instruction) of instruction will be compared in an effort to isolate any secondary impacts of training mode of subsequent performance. All comparisons of subsequent performance will be made among the four treatment groups shown in Figure 1. It is expected that an analysis-of-variance model will be devised to assess this hypothesis.

TABLE 4.

TROUBLE-SHOOTING TEST
DATA RECORDING SHEET

Student Name ________________

Observer ________________

Note Time	Steps Completed	Yes	No	ERROR NOTED (indicate step # and your comment)
0	. . . .			
	1. Remove all jewelry.			
	2. Test station preparation.			
	3. Turn-on procedures.			
	4. Feel/Trim visual inspection.			
	5. Selection/hook-up of correct adapter.			
	6. Cabling LRU to test station.			
	7. Set MODE SWITCH to "normal."			
	8. Enter and request test #830401.			
	9. Verify test number, press START.			
	10. *Verify test date, press START.*			
____	. . . .			
	11. Does LRU pass test #300150.			
	Note: Test station only--"jump" testing sequence to #300600.			
	12. Testing halts at #300610; enter #300650, TEST REQUEST, START.			
	13. Testing halts at #300755; when "go," press START, *observe increasing +* voltage, press START.			
	14. Testing halts at #300764; when "go," press START, observe increasing - voltage, press START.			
	15. Testing halts at #300824; enter #300830, TEST REQUEST, START.			
	Note: Test station only--"jump" testing sequence to #301400.			
	16. Testing halts at #301752; rotate OSCP, INPUT SIGNAL SEL switch to "digital multr."			
____	. . . .			
	17. Press NEG DC COUPLING switch.			
	18. Press POS DC COUPLING switch.			
	19. Set VERNIER to "fully cw."			

TABLE 4. (cont.)

Note Time	Steps Completed	Yes	No	Error Noted
	20. Set V/DIV at .5.	___	___	
	21. Set SWEEP MODE on "auto."	___	___	
	Note: Reset system to allow rerun of test tape. On student console, press FAULT DETECT/RETURN. No comments to the student.			
	22. Adjust to obtain display, observe sine wave (should not be there).	___	___	
	. . . .			
	23. Determine that the Yaw Board TB3 is defective.			
	24. Rerun test tape from #301740.			
	25. Advise board replacement.	___	___	
________	. . . .			
	Note: Indicate TB3 is replaced. On student console, press FAULT DETECT/RETURN.			
	26. Rerun test tape from #301740.			
	27. Student should offer alternative explanations of malfunction. (Instructor should only state that "Yaw Board TB3 was apparently not the cause.")	___	___	
________	. . . .			
	28. After 5 minutes: Instructor suggests that "test station caused the malfunction."	___	___	
	29. After another 5 minutes: Instructor suggests that "the test program should be decoded."	___	___	
	30. Student decodes program in total.	___	___	
	31. Student decodes program in part.	___	___	
	32. Student identifies missing power input.	___	___	
	33. Student notes that power light is off.	___	___	
________	. . . .			
	34. Student suggests alternative explanations for lack of power.	___	___	
	35. Students suggests that a fuse has blown.	___	___	
________	. . . .			

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To test hypothesis #2, the accuracy of groups A and C will be compared with that of B and D as shown in Figure 1 on the Trouble-shooting Test. In this case, a 2 x 2 analysis-of-variance will be required and a significant main effect of training mode will be necessary to reject the hypothesis that simulator-trained and actual equipment-trained students are equally accurate in solving trouble-shooting problems.

Hypothesis #3 will be tested by comparing the number and nature of errors committed and time of completion for groups A and C, and B and D.

Hypothesis #4 will be tested by comparing the accuracy, time, and error patterns of group C with group D. Recall that both of these groups will be tested only on the actual equipment. A planned comparison between groups C and D is proposed to assess this hypothesis. Of course, the analysis-of-variance must show some significant differences in order for the data to potentially reject this hypothesis.

To test hypothesis #5, a modification will be introduced into the testing procedure. Teams of students will be created--one member from each training mode. The confidence of approaching the task will be assessed by subjective ratings of each team member's role in solving the problem. This will require some changes in assigning classes to training modes. Therefore, this hypothesis will be tested only after sufficient data have been collected to adequately assess all previous hypotheses.

COMPONENT 2: ASSESSMENT OF JOB PROFICIENCY

As proposed, the major objective of this aspect of the evaluation is to determine if 3-level avionics maintenance personnel perform differently in the field as a function of the mode of training. To address this issue, three hypotheses will be tested:

Hy 6--Airmen trained on the 6883 simulator and the 6883 test station will acquire equivalent job-related experience.

Hy 7--Airmen trained on the 6883 simulator and 6883 test station will be equally capable of operating the 6883 test station in the field.

Hy 8--Airmen trained on the 6883 simulator and the 6883 test station are equally capable of operating assigned test stations, other than the 6883 station, in the field.

Relevant Issues

The performance of simulator-trained personnel would be compared to the performance of actual equipment-trained personnel at specified intervals of time in the field. The effects of on-the-job training were expected to be present in both groups and, therefore, any differences in performance could be attributed to the mode of training. Further, the proposed time series sampling framework (Figure 4) was based on the assumption that student flow would be 45 for a one-year period as suggested in the Request for Proposal.

From our discussions with ATC staff and field personnel, a number of facts have emerged which must be considered if we are to appropriately assess the impact of simulator training of job performance in the field. First, ATC now estimates the student flow through the F-111 avionics maintenance courses, which include instruction in the operation and maintenance of the 6883 test station, to be approximately 180 airmen during the 1979 calendar year. It has become apparent, however, that field assignments are made in view of the momentary demand for specific automatic test station operators. Thus, at best, only a small, undetermined number of airmen trained to operate the 6883 test station can be expected to actually be assigned to the 6883 or 6873 test stations in the field. Further complicating the evaluation plan is the fact that student flow is not expected to be at a constant level throughout the year. Thus, the testing plan must remain flexible enough to collect data whenever students are available. The hypotheses stated above will permit taking advantage of all simulator-trained personnel and to address the impact of training on the subsequent operation of the

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1	2	3	4	5	6	7	8	9	10	11	12
6883 Practical Instruction Training									Data Collection Effort		

Months in the Field	Project Month Experimental Students Enter the Field: 1	2	3	4	5	6	7	8	9	No. of Students Available for Field Testing
1	5*	5	5	5	5	5	5	5	5	45
2		5	5	5	5	5	5	5	5	40
3			5	5	5	5	5	5	5	35
4				5	5	5	5	5	5	30
5					5	5	5	5	5	25
6						5	5	5	5	20
7							5	5	5	15
8								5	5	10
9									5	5

*For purposes of illustration, these numbers are based on the assumption that five airmen will graduate each month. We expect the actual number to be higher and more variable across months.

Figure 4. Expected Sampling Framework for Simulator-Trained Students

January 1979

1	2	3	4	5	6	7	8	9	10	11	12
6883 Practical Instruction Training									Data Collection Effort		

Months in the Field	Project Month Experimental Students Enter the Field: 1	2	3	4	5	6	7	8	9	No. of Students Available for Field Testing
1	5*	5	5	5	5	5	5	5	5	45
2		5	5	5	5	5	5	5	5	40
3			5	5	5	5	5	5	5	35
4				5	5	5	5	5	5	30
5					5	5	5	5	5	25
6						5	5	5	5	20
7							5	5	5	15
8								5	5	10
9									5	5

*For purposes of illustration, these numbers are based on the assumption that five airmen will graduate each month. We expect the actual number to be higher and more variable across months.

Figure 4. Expected Sampling Framework for Simulator-Trained Students

6883 (or 6873) test station itself, as well as address the issue of generalizability of simulator training to the operation of other automatic test stations. Second, field personnel have pointed out that on-the-job training is tailored to the individual needs of airmen. The amount of training provided and the response to that training are not formally documented. Thus, we cannot expect the nature of impact of on-the-job training to be consistent across groups much less among individuals. On-the-job training is given to increase job proficiency. Promotion, presumably based on proficiency, is therefore determined in part by the subjective judgements of field supervisors. In short, there is no systematic testing protocol currently implemented in the field which could be used to track changes in job proficiency over time. Our data collection effort must be designed in view of the "uncontrolled" nature of the field environment.

The third issue affecting the data collection efforts in the field is that the reorientation of training objectives (discussed in a previous section) requires a change in the job requirements of automatic test station operators. Perhaps most important is the fact that the F-111 avionics maintenance personnel are now expected to be both test station operators and maintainers. To be efficient, airmen must be knowledgeable about the relationship between LRU and test station circuitry. Since the job requirements are somewhat different than training objectives, at least in practice, it is critical that a performance test be developed in view of field activities.

Methodology

The groups shown in Figure 1 will be considered as four treatment groups for the purpose of assessing job-related knowledge. Since this test will be field-oriented, and will not directly mirror training objectives, it will not be necessary to control for the sequence of training in the 6883 practical block of instruction. At the completion of this block of instruction, the paper and pencil test will be administered to all students.

The approach to collecting data in the field will be to compare the subjective evaluations of students by field supervisors at three, six and nine months after field assignment. The eight groups for which data will be collected are shown in Figure 2. It will be necessary to employ the time series sampling framework for data collection, since ATC graduates will be entering the field at various intervals throughout the year. A schedule of evaluation dates will be provided to field supervisors for all airmen in the original four treatment groups.

Data Collection Instruments

Two data collection instruments will be required to test the three hypotheses associated with this component of the evaluation plan: the Estimated Job Proficiency Test and the Field Performance Inventory.

The Estimated Job Proficiency Test consists of items created by field supervisors and other selected field personnel. The items are designed to determine the level of knowledge and skills deemed necessary for adequate performance in the field. So constructed, the test is expected to address performance ability beyond training objectives or Specialty Training Standards. This test will be administered to all students upon completion of the 6883 practical block of instruction.

The Field Performance Inventory will be designed as a questionnaire to be completed by the field supervisor. The items will address field performance of graduates of course 3ARB32634A after three, six, and nine months in the field. The questionnaire will be designed so that consistent data will be collected at each time interval.

Hypothesis Testing

To test hypothesis #6, test scores on the Estimated Job Proficiency Test will be compared for the four basic groups shown in Figure 1. The hypothesis will be rejected if a significant main effect of training mode is obtained.

To test hypothesis #7, only airmen assigned to the 6883 or 6873 test station will be considered. For this group, a comparison of subjective performance ratings will be made for students trained on the 6883 simulator versus those trained on the actual equipment.

The test of hypothesis #8 will be identical to that for hypothesis #7, except that only airmen assigned to automatic test stations <u>other than</u> the 6883 or 6873 will be considered. Again, subjective performance ratings will be compared to isolate any differences due to mode of training.

COMPONENT 3: COST ANALYSIS

As originally proposed, the purpose of this component of the evaluation effort is to document all significant cost associated with the use of the 6883 simulator and the actual test station equipment for training. The resulting comparative cost analysis will provide data which can be used for making decisions concerning the procurement and use of similar equipment in the future.

Methodology

In order to conduct a systematic comparison of costs, a basic model or framework has been developed which includes the six major cost categories shown in Table 5. The basic model is a matrix which has cost categories and life cycle as the two primary dimensions. To conduct an analysis, a detailed matrix which includes specific line items for each major category will be completed. These detailed cost breakdowns for each of the six major categories are shown in Tables 6-11.

TABLE 5. BASIC COST COMPARISON MODEL

Cost Categories	Life Cycle		
	R&D	Investment Purchase/Supplemental Start-up	Operating Years 1-n
Facilities			
Equipment			
Instructional Material/Training			
Instructors			
Students			
Miscellaneous			

It should be noted that the line items selected will allow the model to be consistently applied in a wide variety of situations where a choice between the use of simulated and actual test station equipment for training might be made. It is not unlikely, therefore, that in any given application of the model, many of the line items will be considered irrelevant or sunk costs. In these cases, they would be recorded as zero costs. For example, one of the life cycle categories is research and development (R&D). To estimate the cost of

TABLE 6. LINE ITEMS ASSOCIATED WITH FACILITIES CATEGORY

		LIFE CYCLE																		
		RESEARCH AND DEVELOPMENT	INVESTMENT			OPERATING (YEARS)														
	Line Items		Equipment Purchase	Supple-mentals	Start-up	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
FACILITIES CATEGORY	1. Renovation (cost/ft.^{2} or total)																			
	2. New construction (cost/ft.^{2} or total)																			
	3. Supplemental requirements (e.g., power source, air conditioning)																			
	4. Supplemental furnishings (cabinets, desks, chairs--not part of equipment)																			
	5. Labor for supplementals not elsewhere accounted for																			
	6. Annual cost of operating, maintaining facilities, supplementals (cost/ft.^{2} or total)																			
	7. Other																			

TABLE 7. LINE ITEMS ASSOCIATED WITH EQUIPMENT CATEGORY

		LIFE CYCLE																		
		RESEARCH AND DEVELOPMENT	INVESTMENT			OPERATING (YEARS)														
	Line Items		Equipment Purchase	Supple- mentals	Start-up	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
EQUIPMENT CATEGORY	1. Effort, material cost in specifications																			
	2. Cost of bid procurement, e.g., travel, labor																			
	3. Acquisition cost/purchase price - physical unit																			
	- software/courseware																			
	4. Shipping (if not accounted for)																			
	5. Installation (if not accounted for)																			
	6. Adaptions/changes at installation time																			
	7. Initial parts inventory																			
	8. Additional equipment--subsequent years																			
	9. Engineering/programming changes--subsequent years																			
	10. Annual parts expense (not in initial inventory)																			
	11. Annual operating/maintenance costs - repair labor																			
	- power use																			
	12. Other																			

TABLE 8. LINE ITEMS ASSOCIATED WITH INSTRUCTIONAL MATERIALS/TRAINING CATEGORY

		LIFE CYCLE																			
		RESEARCH AND DEVELOPMENT	INVESTMENT			OPERATING (YEARS)															
	Line Items		Equipment Purchase	Supple-mentals	Start-up	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
MATERIALS/TRAINING CATEGORY	1. Preparation of unique instruction or training material (hours x rate)																				
	2. Reproducing above material																				
	3. Update factor--subsequent years																				
	4. Original training of instructors-- Trainer (no x rate x hours) = trainee (no. x rate x hours)																				
	5. Update factor--subsequent years																				
	6. Other																				

TABLE 9. LINE ITEMS ASSOCIATED WITH INSTRUCTORS CATEGORY

		LIFE CYCLE																		
		RESEARCH AND DEVELOPMENT	INVESTMENT			OPERATING (YEARS)														
	Line Items		Equipment Purchase	Supple-mentals	Start-up	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
INSTRUCTORS CATEGORY	1. Annual cost (classroom time) (no. x hours x rate)																			
	2. Annual cost (non-classroom time)																			
	3. Preparation of TO data																			
	4. Other																			

TABLE 10. LINE ITEMS ASSOCIATED WITH STUDENTS CATEGORY

	Line Items	LIFE CYCLE																		
		RESEARCH AND DEVELOPMENT	INVESTMENT			OPERATING (YEARS)														
			Equipment Purchase	Supple-mentals	Start-up	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
STUDENTS CATEGORY	1. Hrs/student x no. of students x hourly rate																			
	2. Other																			

TABLE 11. LINE ITEMS ASSOCIATED WITH MISCELLANEOUS CATEGORY

		LIFE CYCLE																		
		RESEARCH AND DEVELOPMENT	INVESTMENT			OPERATING (YEARS)														
	Line Items		Equipment Purchase	Supple-mentals	Start-up	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
MISCELLANEOUS CATEGORY	1. Documentation																			
	2. Administration																			
	3. Other																			

acquiring a simulator, R&D incurred by the manufacturer may not be separately identifiable to the purchaser and may be simply included in the purchase price. R&D costs associated with an actual test station were most likely incurred as part of the cost of instrument development for field use. Thus, in estimating the cost of acquiring an actual test station for training, it would be inappropriate to include R&D costs. An example of sunk cost would be the previous acquisition cost of actual test station equipment which is involved in the decision of whether to continue operation of that equipment or to purchase and operate a simulated test station. In short, the determination of which costs are relevant is completely dependent on the decision being made at a specific point in time.

Application of the Model

A model is an intermediate step between inputs and outputs; a model by itself cannot generate the necessary cost data. The inputs and their values have to be externally derived. In some cost categories, the value of an input can be accurately determined, while others can only be estimated. That is, actual costs could be obtained from competitive bids from qualified contractors whereas cost estimates can be made on the basis of previous experience or historical records.

Realizing that the output of the cost model is only as reliable as the data input, the following five steps in applying the model in a given context are essential:

1. Define the question to be answered. This step is crucial because the decision to be made will determine which cost categories and line items are relevant.

2. Establish life cycle. Fifteen years is the recommended life cycle since that is consistent with past Air Force policy.

3. Determine or estimate input values. This step may be the most time consuming. Some line items may only be estimated as a percentage of a reference cost (e.g., parts as a percentage of purchase price). In addition, there may be some concern regarding purchase options not essential to meet stated training objectives. An actual test station may be available which is significantly overdesigned for training purposes. In assessing the simulated equipment alternative, a similarly overdesigned test station or a simulator designed in view of course objectives might be considered. To illustrate, consider that a basic simulator capability is available at a base price of $300,000. Ten additional capabilities will cost $50,000 each. However, only four capabilities are needed to provide training consistent with course objectives. The total purchase price of this alternative is

$300,000 + (4)($50,000) = $500,000. On the other hand, the actual test station available costs $1 million; but 50 percent of the price represents capabilities beyond those needed for the course. Nevertheless, the relevant price of this alternative is $1 million unless unwanted capabilities can be used to meet other training requirements, in which case, appropriate cost adjustments can be made.

4. Exercise the model. All actual or estimated costs are input into the model and all irrelevant costs are considered zero.

5. Express result in present value, using accepted discount factor. Different cost streams may have different impacts, depending upon the time at which costs are incurred. Present value is a widely accepted method of accounting for differences in time patterns.

SUMMARY OF HYPOTHESES TO BE TESTED

Table 12 shows all hypotheses to be tested and the sample, data collecting instrument, and measure to be used. The time of data collection is also indicated.

It should be noted that additional hypotheses could be considered as the evaluation progresses. This could result from changes in ATC activities or the emergence of an apparent unanticipated impact which must be verified. The assessment of additional hypotheses should involve no new data collection instruments or increased demands on ATC or field personnel. Rather, existing procedures will be modified to accommodate any new evaluation requirements.

TABLE 12. SUMMARY OF HYPOTHESES AND RELATED DATA COLLECTION EFFORTS

Hypotheses	Sample	Data Collection Instrument	Measures	Time of Testing
Hy 1--Practical training on the 6883 simulator and the 6883 test station results in identical performance on the standard ATC block tests for subsequent training.	All airmen receiving practical instruction in the operation and maintenance of the 6883 test station	End-of-block exams of practical instruction of 6883 test stations; all subsequent end-of-block exams	End-of-block test scores	End of practical 6883 block of instruction
Hy 2--Airmen trained on the 6883 simulator and the 6883 test station are equally accurate in solving trouble-shooting problems.	All airmen receiving practical instruction in the operation and maintenance of the 6883 test station	Trouble-shooting Test	Accuracy of solution	End of practical 6883 block of instruction
Hy 3--Airmen trained on the 6883 simulator and the 6883 test station are equally efficient in solving trouble-shooting problems.	All airmen receiving practical instruction in the operation and maintenance of the 6883 test station	Trouble-shooting Test	Number and nature of errors committed; time to completion	End of practical 6883 block of instruction
Hy 4--Airmen trained on the 6883 simulator and the 6883 test station operate the actual test station with equal proficiency.	All students tested on the actual test station equipment for trouble-shooting ability	Trouble-shooting Test	Accuracy error rate and time to completion	End of practical 6883 block of instruction

TABLE 12. (cont.)

Hypotheses	Sample	Data Collection Instrument	Measures	Time of Testing
Hy 5--Airmen trained on the 6883 simulator and 6883 test station are equally familiar and comfortable in operating the actual test station without supervision.	2-person teams of students; one member from each mode of training group	Trouble-shooting Test	Instructor rating of "active" and "passive" role in problem solving accuracy, error rate and time to completion	End of practical 6883 block of instruction
Hy 6--Airmen trained on the 6883 simulator and the 6883 test station will acquire equivalent job-related experience.	All airmen receiving practical instruction in the operation and maintenance of the 6883 test station	Estimated Job Proficiency Test	Test scores	End of practical 6883 block of instruction
Hy 7--Airmen trained on the 6883 simulator and 6883 test station will be equally capable of operating the 6883 test station in the field	All airmen assigned to the 6883 or 6873 test station in the field	Field Performance Inventory	Subjective ratings of performance	After 3, 6, 9 months in the field
Hy 8--Airmen trained on the 6883 simulator and 6883 test station are equally capable of operating assigned test stations, other than the 6883 station, in the field.	All airmen assigned to F-111 automatic test stations other than the 6883 or 6873	Field Performance Inventory	Subjective ratings of performance	After 3, 6, 9 months in the field

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APPENDIX A

EVOLUTION OF 6883 TEST STATIONS TRAINING OBJECTIVES

Current POI	Current STS		Prior Status		
Objectives of 6883 Theory Block of Instruction (course X1F/X4A)	STS-X4A Reference and Description		Previously taught in		
			XOB	XID	Interim
1. Purpose and function of converter-flight control test station					
a. Given the appropriate TO, identify the purpose and function of the converter-flight control test station and its TRU's.	27a.	Computer/navigation and flight controls/converter and flight controls test station functions and purpose	1a (27a,b)	5b (10a1)	✓
2. F-111 flight control terms					
a. Given a list of flight control terms, indicate from memory, the function/definition for each term.	16.	Radar, navigation and flight control principles			
3. Theory/Data flow analysis of multiplexer converter (C/S)					
a. Given the appropriate TO and a list of signals for the Converter Set, identify the type and/or characteristics of each.	28a3.	General multiplexer converter information and electrical characteristics		2a (27a2)	✓
b. Given the appropriate TO and a list of signals for the Converter Set, identify the SRU's used to convert each signal.	28b3.	Multiplexer converter data flow and interface with test station		2b (27b2)	✓
c. Given the appropriate TO and a list of signals for the Converter Set, identify the Plug and Pin for each.	28b3.	Multiplexer converter data flow and interface with test station		2b (27b2)	✓

Current POI	Current STS		Prior Status		
Objectives of 6883 Theory Block of Instruction (course X1F/X4A)	STS-X4A Reference and Description		Previously taught in		
			XOB	XID	Interim
4. Theory/Data flow analysis of Feel and Trim assembly					
a. Given the appropriate TO and a list of circuits for the feel and trim, identify the function of each circuit.	28a1.	General feel and trim information and electrical characteristics		4a (27a1)	✓
b. Given the appropriate TO and a list of feel and trim signals, identify the test station plug and pin where each signal is found.	28b1.	Feel and trim data flow and interface with test station		4b (27b1)	✓
5. Theory/Data flow analysis of the Signal Converter Stimulator (SCS)					
a. Given the appropriate TO and a list of desired outputs wanted from the signal converter simulator (SCS), generate a program to acquire those outputs.	27b10.	Theory and signal flow of the signal converter simulator	2a (27c)		
b. Given the appropriate TO and the block diagrams for the different modes of operation for the signal converter simulator, identify the function(s) of the blocks.	27b10.	Theory and signal flow of the signal converter simulator.	2a (27c)		

Current POI: Objectives of 6883 Theory Block of Instruction (course X1F/X4A)	Current STS: STS-X4A Reference and Description	Prior Status: Previously taught in XOB	XID	Interim
c. Given the schematic, condition of inputs and the appropriate TO of an SRU for the signal converter simulator, determine output of the SRU.	27b10. Theory and signal flow of the signal converter simulator	2a (27c)		
d. Given the appropriate TO and a list of signals used by the signal converter simulator, identify the plug and pin where the signal is found.	27b10. Theory and signal flow of the signal converter simulator	2a (27c)		
6. <u>Theory/Data flow analysis of parallel digital adapter, SCU controller, and digital interface unit</u>				
a. Given a block diagram of the parallel digital adapter and the appropriate TO, identify the function of the blocks.	27b7. Theory and signal flow of the parallel digital adapter	2a		
b. Given an SRU designator of the SCU controller and the appropriate TO, identify the function of the SRU.	27b6. Theory and signal flow of the SCU controller	2a		
c. Given a block diagram of the Digital Interface Unit and the appropriate TO, identify the function of the blocks.	27b9. Theory and signal flow of the digital interface unit	2a		√

Current POI	Current STS		Prior Status		
Objectives of 6883 Theory Block of Instruction (course X1F/X4A)	STS-X4A Reference and Description		Previously taught in		
			XOB	XID	Interim
7. <u>Theory/Data flow analysis of the Serial Digital Adapter (SDA)</u>					
a. Given appropriate TO and a block diagram for each mode of operation of the Serial Digital Adapter (SDA), identify the function of the block(s).	27b8.	Theory and signal flow of the serial digital adapter	2a		√
b. Given appropriate TO and a list of programming for the Serial Digital Adapter, decode each program.	27b8.	Theory and signal flow of the serial digital adapter	2a		√
c. Given appropriate TO, a schematic of a Serial Digital Adapter SRU, and the input conditions to that SRU, determine condition of a selected input.	27b8.	Theory and signal flow of the serial digital adapter	2a		√
d. Given appropriate TO, and a list of Serial Digital Adapter signals, determine the plug and pin where the signal is found.	27b8.	Theory and signal flow of the serial digital adapter	2a		√
8. <u>Theory/Data flow analysis of Switching Control Unit</u>					
a. Given a block diagram of the Switching Control Unit and the appropriate TO, identify the function of the block(s).	27b2.	Theory and signal flow of the switching control unit	3a		√

Current POI	Current STS		Prior Status		
Objectives of 6883 Theory Block of Instruction (course X1F/X4A)	STS-X4A Reference and Description		Previously taught in		
			XOB	XID	Interim
b. Given a list of programs for the Switching Control Unit and the appropriate TO, decode each program.	27b2.	Theory and signal flow of the switching control unit	3a		√
c. Given a schematic, condition of the inputs, and the appropriate TO, for an SRU of the Switching Control Unit, determine the condition of the output of the SRU.	27b2.	Theory and signal flow of the switching control unit	3a		√
d. Given a list of signals and the appropriate TO, indicate the Switching Control Unit plug and pin where each signal is found.	27b2.	Theory and signal flow of the switching control unit	3a		√
9. Theory/Data flow analysis of the FCS Adapter					
a. Given a block diagram of the FCS Adapter and appropriate TO, identify the function of the blocks.	27b4.	Theory and signal flow of the FCS adapter	3a		√
b. Given the appropriate TO, trace data flow through the FCS Adapter.	27b4.	Theory and signal flow of the FCS adapter	3a		√
c. Given a list of programs for the FCS Adapter and the appropriate TO, decode each program.	27b4.	Theory and signal flow of the FCS adapter	3a		√

Current POI		Current STS	Prior Status		
Objectives of 6883 Theory Block of Instruction (course X1F/X4A)		STS-X4A Reference and Description	Previously taught in		
			XOB	XID	Interim
10. Theory/Data Flow Analysis of Switching Complex					
a. Given the block diagram of the Switching Complex and the appropriate TO, identify the function(s) of the blocks.	27b1.	Theory and signal flow of the switching complex	3a		✓
b. Given the appropriate TO and a list of signals from selected TRU's, identify the pin on A3A2A15 where the signal enters or exits.	27b1.	Theory and signal flow of the switching complex	3a		✓
11. Measurement and Critique					
a. Measurement					
b. Critique					

Current POI: Objectives of 6883 Practical Block of Instruction (course X1F/X4A)	Current STS: STS-X4A Reference and Description		Prior Status: Previously taught in XOB	XID	Interim
1. <u>Operation of Conv. Flt. Cont. T/S for Maintenance Testing</u>					
a. Given the appropriate tech data, operate the Conv. Flt. Control Test Station and shop standards to perform diagnostic testing.	27d1.	Operate test station and shop standards to perform diagnostic testing.	7a (27f1)		
b. Given the appropriate test equipment and tech data, locate the cause of instructor selected malfunctions for the Conv. Flt. Control Test Station.	27d2.	Operate test station and shop standards to trouble-shoot malfunctions.	7c (27f2)		
2. <u>Evaluation - Maintenance</u>					
3. <u>Operation of Feel and Trim</u>					
a. Given appropriate tech data, operate test station and associated test equipment to test and and inspect feel and trim.	28c1.	Operate test station and associated test equipment to test and inspect feel and trim.		6a (27c1, d1)	✓
b. Given appropriate tech data, operate test station and associated test equipment to isolate malfunctions of the feel and trim.	28d1.	Operate test station and associated test equipment to isolate malfunctions of feel and trim.		6b (27d4)	✓
4. <u>Evaluation Feel and Trim</u>					

Current POI	Current STS	Prior Status		
Objectives of 6883 Practical Block of Instruction (course X1F/X4A)	STS-X4A Reference and Description	Previously taught in		
		XOB	XID	Interim
5. Operation of Converter Set				
a. Given appropriate tech data, operate test station and associated test equipment to test and inspect converter set.	28c3. Operate test station and associated test equipment to test and inspect multiplex converter.		6d (27c2, d2)	✓
b. Given appropriate tech data, operate test station and associated test equipment to isolate malfunctions of the converter set.	28d3. Operate test station and associated test equipment to isolate malfunctions of the multiplex converter.		6e (27e5)	✓
6. Evaluation - Converter Set				

APPENDIX B

FORMER 6883 INSTRUCTION BLOCK OBJECTIVES DELETED FROM CURRENT BLOCK

FORMER 6883 BLOCK OBJECTIVES NOT INCLUDED IN COURSE X4A

6883 block objectives of course X1D which address X1D STS's which are retained in STS X4A but are not addressed by POI for new course	Current X4A STS Reference
3. Data flow analysis of the flight control computers	
a. Provided with TO 5A7-3-14-2 and a list of selected Yaw Computer subassemblies, state the function of each.	28a4
b. Provided with TO 5A7-3-14-2 and a list of selected Yaw Computer signals, state the plug and pin numbers where the signals appear.	28b4
c. Provided with TO 5A7-3-15-2 and a TO 5A7-3-16-2 and a list of selected Pitch and Roll Computer subassemblies, state the function of each.	28a4
d. Provided with TO 5A7-3-15-2 and TO 5A7-3-16-2 and a list of selected Pitch and Roll Computer signals, state the plug and pin numbers where the signals appear.	28b4
5. Theory of operation of the converter-flight controls system test station	
*a. Provided with TO 33D7-17-15-2 and a list of selected test station operation procedures, state the methods of operation.	16
6.	
c. Provided with TO 5A9-2-42-22 and TO 5A9-2-42-28-1 and the previously identified causes of known feel and trim assembly malfunctions, perform the repair action.	28e1
f. Provided with TO 11F15-3-17-2 and TO 11F15-3-17-8-1 and the previously identified causes of known multiplexer converter malfunctions, perform the repair action.	28e3

*This objective may be judged to be included since 16 is referenced in the POI for course X4A.

6883 block objectives of course X1D which address X1D STS's which are retained in STS X4A but are not addressed by POI for new course	Current X4A STS Reference
6. g. Provided with TO 5A7-3-14-8-1, state the procedures to inspect, connect, and test the Yaw flight control computer.	28c4
h. Provided with TO 5A7-3-14-8-1 and selected malfunctions of the Yaw flight control computer, state the cause of each malfunction.	28d4

6883 block objectives of course XOB which address XOB STS's which are retained in STS X4A but are not addressed by POI for new course	Current X4A STS Reference
NOTE: These objectives are in practical block of instruction.	
2. Calibration/verification, alignment and troubleshooting analysis of the converter-flight control systems test station.	
a. Using TO 33D7-17-15-2, perform verification/calibration of peculiar TRU's of the converter-flight control systems test station.	27d4
**c. With instructor assistance, isolate the cause of two specified NO-GO conditions following procedures listed in TO 33D7-17-15-8-1 to the lowest replaceable component.	27d3

6883 block objectives of course X1D INTERIM which address STS requirements that are related in STS X4A but are not addressed by POI for new course	Current X4A STS Reference
6f. See objectives for X1D.	28e3
1. (practical)	
Given TO 33D7-47-13-2 and TO 33D7-47-13-8-1, perform Turn-on procedures and confidence testing.	27c

**It is not clear that this objective was ever addressed in referenced task. The reference also shows up in objective 1a.